

Do Scaled and Spectrum-matched Near-Source Records Produce Biased Nonlinear Structural Responses?

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Designing a new structure or assessing the performance of an existing one is often complicated by the scarcity or absence of real recordings for the earthquake scenarios that dominate the seismic hazard at the structure site. Scaling real records to a target level or modifying the frequency content and phasing of real records to match a smooth target spectrum are two techniques that are used in practice to address this problem. A systematic statistical study that investigates the viability of these two approaches in terms of possible response bias and variability reduction is currently not available. This article studies the nonlinear response of Single-Degree-of-Freedom (SDOF) oscillators of different periods and strengths subject to real un-scaled records, amplitude-scaled records, and spectrum-compatible records from an intermediate-magnitude, short-distance, forward-directivity scenario. The nonlinear response of a real building subject to such a suite of ground motions will also be briefly discussed. The results show that amplitude scaling tends to make the records more damaging, whereas the spectrum matching approach tends to make them more benign than real, un-scaled records. Both procedures, however, reduce the record-to-record response variability and, therefore, are useful for response prediction in that they require fewer records than real un-scaled ones for estimating the median response with the same level of precision. The amount of bias and variability reduction depends on the structure period and strength. Engineers should be aware of the possible systematic bias in the nonlinear structural response introduced by these techniques and correct for it, if appropriate.